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PAPER

The Role of Mobile Games and Environmental Factors in Improving Learning and Metacognitive Potential of Young Students

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ABSTRACT

Environmental sensitivity, which refers to the capacity to recognize and react to environmental stimuli, has been linked to increased levels of metacognition, which is the capacity to learn about one's own learning processes. Sensory processing sensitivity (SPS) is a characteristic that can make people more sensitive to the stimuli and settings in their surroundings. Regarding the development of mobile game-based educational procedures, the study of the neurocognitive bases of the mechanisms underlying them, such as metacognition and environmental factors, could play a crucial role in the implementation of these educational practices. The purpose of the current narrative review is to identify the key mechanisms by which mobile games affect young learners' metacognitive and environmental sensitivity profiles and to suggest future research directions on the specific selection of gamification-based educational interventions.

KEYWORDS

sensitivity, childhood, gamification, metacognition, learning, neurocognition

1 INTRODUCTION

The term "metacognition" refers to a learner's awareness of their own cognition and cognitive processes [1]. Reflective abilities and the capacity to self-regulate mental processes are both incorporated into the idea of metacognition [2]. A child should have the best learning results possible from a developmental standpoint when metacognitive skills are successfully implemented. According to this theory, it is expected that a young learner will acquire and use the best possible levels of metacognitive skills that will help him or her monitor, control, and modify his or her own internal cognitive processes. Due to a growing awareness of the need to take steps to educate self-regulated and self-directed learners who can employ autonomous digital technologies to aid their self-learning capacity, there has been a resurgence in interest in

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the literature around metacognition in more recent years [3]. Schools are the ideal settings for meta-cognition because they have a major impact on a person's capacity to experience need satisfaction, which can also boost motivation and increase school involvement [4] [5].

From a children's learning-developmental perspective, they are also influenced by a range of non-cognitive factors, such as personality and the environment of the classroom, besides their IQ. One of the most in-depth theories on sensitivity to environmental stimuli in recent years is the concept of sensory processing sensitivity (SPS), which is characterized by high environmental sensitivity [6] [7]. Despite extensive adult research on SPS, children's literature has only lately become a focus of attention [7]. From a learning standpoint, it is feasible that arrangements in the school environment and specialized educational interventions may have a different effect on kids who have features that make them more susceptible to environmental stimuli.

Additionally, information technologies are being used more and more in educational settings with the goal of maximizing kids' learning potential in a variety of ways. For instance, [8] shows how information technology has been utilized to design tailored learning experiences for each learner. Gamification-based learning experiences can be developed using information technology, and these possibilities have been shown to be more motivating and engaging for students [9]. This is especially relevant to the currently chosen review. Mobile game-based learning platforms can provide students with a fun and interesting approach to learning while also monitoring their progress and providing them with tailored feedback [10].

It's intriguing to see that more and more evidence is emphasizing the crucial neurocognitive mechanisms at play in SPS and metacognition. Designing gamification-based educational interventions that are based on the learner's specific neurocognitive profile will be very important for designing technology-assisted educational interventions. Delinquently making such potential multidirectional contributions will be essential for doing this.

2 MATERIALS AND METHODS

The first section of this paper is devoted to the presentation of key theories surrounding metacognition, environmental sensitivity, and early learning. More specifically, the section presents briefly the self-determination theory (SDT) and its contribution to better understanding early learning. Moving on, the key concepts surrounding SPS are also presented, along with their key implications for development and behavior. The section is concluded with a cross-theory discussion between the key constructs of interest, metacognition, sensitivity, and gamification-based learning.

The second section moves into discussing key evidence in the literature surrounding the neurocognitive underpinnings of metacognition, SPS, and gamification-based learning. The sections aim to highlight key mechanisms that may be involved in regulating metacognition and sensitivity, but also that may be significant in the designation of effective gamification-based learning.

The third and last section concerns the potential implications of the abovementioned neurocognitive mechanisms in designing gamification-based educational interventions with the maximum potential impact on children's learning. Key contributions of such mechanisms to differentiated learning and suggestions on designing learning tools that account for individual differences based on the neurocognitive profile of the young learners are discussed.

3 THEORETICAL BACKGROUND

3.1 Self-determination theory of metacognition and early learning

Self-determination theory is a macro-theory that claims that in order for people to be naturally motivated and involved in their daily activities, a small number of psychological prerequisites must be met [4]. Numerous studies carried out have shown that autonomy (i.e., volition) is particularly crucial for learning new skills because it is linked to positive outcomes such as interest in the course material, conceptual understanding, and classroom adjustment [11]. Internal regulation, in which people act because they feel they should rather than because they want to, is a form of controlled motivation. External regulation, such as reward and punishment contingencies, is another form of controlled motivation. In contrast, identified or integrated regulation is a component of autonomous motivation and happens when people take ownership of the regulation of their own actions because it is personally significant to them. An action is done out of interest because it is enjoyable in and of itself when one is motivated by intrinsic factors [12] [39].

Competency requirements are also linked to knowledge of effectively coordinated conduct. Although Stroet et al. [14] claim that competence is connected to motivation and engagement in learning, Marshik et al. [13] claim that competence denotes the requirement for self-confidence in one's abilities. When they believe they can handle their academic obstacles better, for example, kids are competent. In the same vein, Froiland and Worrell [5] assert that children exhibit higher levels of intrinsic motivation and academic engagement when they feel supported in their need for competence. Students who feel capable but not independent lack the intrinsic drive to learn as a result. The SDT assumption that autonomy and competence are both critical criteria for the preservation of intrinsic motivation is supported by a large body of experimental data to date [15]. Although metacognition has gained a lot of academic attention in the years surrounding primary and higher education, it is frequently ignored in childhood education [16].

According to research, educational initiatives that promote autonomy, competence, and relatedness can also increase students' participation in metacognitive processes and improve academic achievements [17–18]. Meeting these requirements has been referred to as the sense of need satisfaction and has been demonstrated to support psychological development, intrinsic drive, and involvement in academic work [19] [4]. It has been said that the need for relatedness, which is connected to feelings of connection with others, is a fundamental need that might affect learning [14]. For instance, young kids feel a connection to their teachers and peers, which can boost learning outcomes [20]. An individual's need for connection makes them want to be somewhat dependent, rather than completely independent, of someone they trust, but they also need autonomy so they have a sense of will and choice about their own dependence and behavior. The acquisition of such skills may be associated with individual characteristics that relate to one's ability to respond to environmental cues.

3.2 Environmental sensitivity, SPS, and early learning

The environmental sensitivity hypothesis contends that each person's sensitivity to their surroundings varies [21]. Environmental sensitivity has been described as critical for an individual's ability to adapt effectively to the conditions of a given environment, and there are individual differences in the sensitivity profile among different individuals, with some individuals described as more sensitive than others. According to a review study [7], the theories of SPS [22], biological sensitivity to context [23], and differential susceptibility [24] are often referred to as environmental sensitivity. These theories all contend that people with high levels of sensitivity benefit more from supportive environments [25–26], but they also suffer more when exposed to unsupportive environments [27–28]. The only theory, however, that accurately describes environmental sensitivity as a personality attribute is the idea of SPS [7]. Adults are often assessed for SPS using self-report questionnaires, whereas adolescents are assessed using the highly sensitive child (HSC) scale [29–30].

Sensory processing sensitivity is characterized by a particular set of behavioral manifestations, such as emotional reactivity, sensitivity to subtleties, and overstimulation [6] [31]. More specifically, "depth of processing" is related to taking more time to process stimuli in unfamiliar environments [32]. This is also accompanied by "planned behavior," where an individual's response is thought to be more effective in a given or known situation because the individual has already learned how to demonstrate a response [6]. Additionally, emotional reactivity describes someone's stronger emotional reactions to environmental stimuli [33] [35]. Increased awareness of environmental subtleties, such as smells or tastes, is another feature of SPS [7] [22] [34]. Lastly, overstimulation characterizes high-SPS individuals, which can be caused by auditory, visual, and social stimuli [7]. In a similar vein, behavioral studies have suggested that individuals with high SPS scores manifested a greater response when completing a positive mood induction task, which was interpreted as heightened positive affect [35].

Interestingly, SPS may also be important for early learning and child development because it affects how children experience school and how well they learn. High-SPS kids are more sensitive to their environment, according to a few studies in the educational context [25]. These studies, however few, are mostly concerned with preventive rather than daily classroom experiences. For example, in noisy or visually congested situations, children who are extremely sensitive to sensory input may feel overwhelmed or distracted, which can have a negative impact on their attention and capacity to learn. Future studies must provide more information about the benefits of SPS in helping kids realize their individual learning potential both within and outside of the classroom.

3.3 Early learning, metacognition, and environmental sensitivity

The SDT includes the basic psychological need theory, which contends that everyone experiences need satisfaction and need dissatisfaction, regardless of circumstance, personality, or cultural background [4] [36]. According to this idea, effortful control and behavioral regulation are crucial preconditions for both need satisfaction and academic success [37–38]. The significance of need satisfaction, however, may also depend on other personal variables, such as SPS [12] [39]. SPS may affect the significance of need satisfaction for motivation and behavioral engagement within a learning setting because students with greater SPS are more reactive to their environment [6] [7] [31]. Interesting studies have looked at the connection between SPS and behavior. The Pluess et al. study [29], which was based on attention, activation control, and inhibitory control, showed that SPS was most significantly positively correlated with effortful control. This would indicate, in accordance with the SDT, that students with higher SPS are better able to control their behavior, for example, if they choose tasks that are within the range of their abilities (autonomy and competence), get along with their peers (relatedness), and become actively involved in class (behavioral engagement).

Furthermore, there is currently no convincing empirical evidence to establish a major relationship between metacognition and SPS, despite studies looking into this connection. The relationship between SPS and emotional intelligence, a notion related to metacognition, was examined in one study by Acevedo et al. [40]. Despite a minor positive correlation between SPS and emotional intelligence, the study found that this relationship was not statistically significant.

While there isn't much direct evidence connecting metacognition and SPS in terms of child learning, the separate lines of research we highlighted earlier imply that both domains are important for child development and education in various ways. Our understanding of these aspects of children's development will be improved by further research in this area, which will also help to identify the most effective educational strategies for helping kids improve intellectually, socially, and emotionally.

3.4 Environmental sensitivity, metacognition, and game-based learning

Gamification, which is defined as the use of game and mobile game design elements in learning environments, has the potential to support early learning [41–42]. Children are more likely to be motivated to study when learning activities are made more interesting and enjoyable, according to research [43]. Gamification can offer a more dynamic and immersive learning experience that enables kids to grow in motivation, self-efficacy, and high-level thinking in a safe and supervised environment [44]. By monitoring and evaluating each learner's progress, modifying the difficulty, or offering tailored feedback to support learning, gamification can also allow for personalized adjustments to learning experiences [45].

Additionally, the usage of information technologies in schooling may impact metacognition and SPS. Despite the fact that there hasn't been much research, particularly looking at the relationships between information technologies in education, metacognition, and SPS, there is some evidence to suggest that employing technology to promote both constructs may be advantageous. Regarding metacognition, it has been suggested that SDT could serve as a crucial theoretical foundation for developing gamification-based educational interventions that seek to improve students' learning motivation and performance [46]. It has been discovered that classrooms with technological enhancements encourage pupils to become more aware of their own learning processes. For instance, a study by Hadwin et al. [47] found that using a metacognitive tool within an online learning environment improved students' metacognitive awareness and ability to manage their learning. SPS claims that there is currently no direct research on gamification applications in kids' education that take the learner's environmental sensitivity profile into account. Future research to further explore this topic may focus on the precise gamification features that are effective for children with different sensory processing profiles. This topic of research is further developed in the section that follows.

4 NEUROCOGNITIVE MECHANISMS OF METACOGNITION, SPS AND GAMIFICATION-BASED LEARNING

4.1 Metacognition

A crucial component of learning and problem-solving that emerges progressively throughout childhood is metacognition. According to some theories, metacognition starts to take shape during childhood and improves with time, thanks to both learning and brain development. Children should be able to evaluate the accuracy of their information around the age of six, according to Schraw and Moshman [48], but it takes them until they are between the ages of 10 and 14 to be able to control their cognition, which involves planning, monitoring, and evaluating. In a similar vein, more recent observations suggest that during the early years of life, children can reflect on their performance, but there is a mismatch between the accuracy of their evaluation and their actual measured performance [49]. Such skills for effective evaluation of their performance are developmental achievements that come later in life [91]. In this area of inquiry, there are numerous contributors that have been highlighted in empirical research, including training [50], task-relevant feedback and task difficulty levels [49], and working memory [51].

The prefrontal cortex, anterior cingulate cortex, default mode network, and hippocampus are just a few of the brain regions that have been connected to metacognitive functions in studies. In research employing functional magnetic resonance imaging (fMRI), Davidson et al. [52] carefully evaluated how cognitive control and executive functions developed from 4 to 13 years of age. According to the study, the dorsolateral prefrontal cortex, a part of the brain linked to working memory and cognitive control, became more active as people aged when performing activities that required inhibitory control and task switching. A comprehensive explanation of the brain mechanisms governing cognitive control was also suggested in Banich's literature review on executive functions [53]. The anterior cingulate cortex, according to the author, is engaged in conflict monitoring and error detection, and it becomes especially active when kids are given tasks that require them to keep track of their own performance. In a similar vein, a more recent longitudinal fMRI study sought to evaluate the neurobiological bases of nine- to ten-year-old children's metacognitive monitoring as they performed arithmetic tasks and gave performance assessments [54]. According to the study, children's left inferior frontal gyrus grew during the problem-solving task and while engaging in a task involving procedural monitoring. The observed effect was correlated with the participant's arithmetic development during a three-year developmental window, which also highlighted the maturational procedures taking place on the prefrontal cortex and the corresponding development of metacognitive monitoring.

In a study employing fMRI, Ghetti and Bunge [55] looked into the brain changes that underlie the development of episodic memory during middle childhood. Age-related increases in the hippocampus' activity via tasks requiring memory integration and source watching suggest that this area is engaged, combining information from several sources to support metacognitive assessment. Overall, these findings suggest that the maturation of the brain regions responsible for self-awareness, monitoring, control, memory, and self-referential processing promotes the growth of metacognition in young people. However, considering the known limited verbal ability and working memory capacity in the early years of life [56], generating operational definitions and developing accurate neurocognitive measurements of children's metacognitive skills is a rather exigent task [57]. The particular brain mechanisms involved in metacognition and how they change as people age will require more investigation using a variety of techniques and larger sample sizes.

It's interesting to note that there is compelling evidence that both children and adults share the same brain areas that are engaged in metacognition. Nevertheless, depending on the precise metacognitive task presented, the participants' precise developmental stage, and the observed individual variations, the degree of activation within these regions varies among different ages [58]. In a study by Germine et al. [59], the brain correlates of metacognition in a sample of children and adults were examined using fMRI. When making metacognitive assessments of their own performance, both groups exhibited activation in the prefrontal cortex, parietal cortex, and anterior insula, according to their findings. However, the adult individuals showed higher activation in these areas compared to the kid participants, which may indicate that adults' metacognition relies more on these regions. Similar to this, studies have revealed that as people age and gain experience, their prefrontal cortex becomes more concentrated and efficient, which may support the development of metacognitive abilities [52] [60].

The precise pattern of activity and functional connectivity within these regions may change depending on the specific task requirements and the stage of development, similar to how the anterior cingulate cortex, hippocampus, and fault mode network are thought to play a role in metacognition in both children and adults [53] [55] [61]. Overall, both children and adults have the brain regions involved in metacognition, but depending on age and experience, these regions may develop and operate differently. To fully comprehend these brain regions' developmental paths and how they serve metacognitive functions across the lifespan, more research is required.

4.2 Sensory processing sensitivity

Research suggests that a number of brain areas are involved in sensory processing and may have a role in changing sensitivity to sensory inputs, even though the neurological mechanisms behind SPS in children are not fully understood. For instance, the fMRI study by Acevedo and colleagues [62] compared the brain activity of individuals with high and low SPS levels in reaction to emotional stimuli. The activation of brain areas linked to depth of processing, memory, and physiological regulation in response to emotional stimuli is positively correlated with SPS (and its interaction with the early environment). The findings demonstrated that those with high SPS responded to emotional stimuli with more amygdala activation than individuals with low SPS, a brain region involved in processing emotional information. One such brain part is the thalamus, which transmits bodily sensory information to the relevant cortical regions for further processing. Young children's SPS may be related to the thalamus's critical role in filtering sensory data and controlling the flow of information to other brain regions. Accordingly, those with high SPS scores displayed greater activation in the brain regions linked to the visual areas related to fine visual distinctions [32]. Additionally, connections between higher SPS and the activation of working memory and attention-related brain areas were reported by an fMRI study conducted during a task demanding attending to context in the visual landscape [63].

Electroencephalography (EEG) was also employed in a different study by Jagiellowicz et al. [32] to look into how the brain reacts to auditory stimuli in people with high and mild SPS. Overall, the processing of sensory information is probably mediated by the thalamus, primary sensory cortex, and amygdala. This may influence individual differences in susceptibility to sensory inputs [40]. To fully comprehend the brain mechanisms underlying SPS in youngsters, more study is necessary.

4.3 Gamification-based learning

Gamified learning experiences have been proposed to be particularly affective as they offer incentivised conditions that can assist in the engagement of learners in goal-directed behavior [64]. Such an assumption is backed up by data demonstrating that incentives can enhance a specific set of cognitive processes that are critical to learning [65] and incorporate working memory capacity [66–67]. An increasing corpus of research is impressively highlighting the importance of games in educational procedures for children. These findings imply that games can have a positive effect on a number of cognitive functions and brain areas that support motivation and learning. For instance, playing mobile games improved attentional control and visuospatial skills in a randomized controlled trial study of young adults [68]. These mental operations are essential for academic learning as well and can be improved with gamification techniques. Another fMRI study looking at changes in brain activity in response to a gamified math app in youngsters found that the brain's attention and numerical processing regions changed as the children's math skills increased [69]. In a similar vein, fMRI studies have documented that reward can mediate the increased activity in prefrontal and parietal regions that are strongly associated with working memory [70–72]. In activities involving the learning of complicated mathematics, second language acquisition [73], spatial skills [74], and learning in many other areas, activation of the dorsal fronto-parietal network has been reported [75]. It's interesting to note that there is evidence to suggest that when attention is directed toward an external learning activity, the default-mode network (DMN), another brain network linked to top-down modulation of attention and working memory, may become less active. More specifically, it has been found that the DMN activates when attention is diverted from self-referential tasks (i.e., those involving autobiographical memory, theory of mind, and affective decision-making) [76–77].

Additionally, new research has identified emotions as key factors in efficient learning. According to Greipl et al.'s [78] evaluation of neuro-functional activity patterns when participants received feedback, they examined a wide range of brain regions implicated in emotional and rewarding processes (such as the amygdala or ventral tegmental area). The study revealed that mobile game-based learning can support learning processes with the contribution of reward and emotional engagement on a neurofunctional level. This evidence is in line with accumulating evidence that suggests that the emotional engagement of learning can be impacted to facilitate learning processes [79–81].

Overall, these findings point to a positive influence of gamification treatments on cognitive functions and brain areas associated with learning and motivation. These findings show the potential of gamification in educational interventions for young children, but more research is needed to fully comprehend the mechanisms underlying these outcomes and to pinpoint the most effective gamification strategies for various learner types. However, how gamification features are planned and implemented can greatly affect how effective they are. Gamification strategies must be founded in motivation and learning research and tailored to the needs and abilities of each learner.

5 FROM CUSTOMIZED GAMIFICATION-BASED LEARNING TO NEUROCOGNITIVE MECHANISMS

5.1 Early learning and common neurocognitive mechanisms

It would be crucial to consider the fundamental neurocognitive mechanisms that cause individual differences in learning if we wanted the gamification-based learning experience to have the greatest impact on each learner. It's important to note that some evidence suggests the brain circuits responsible for SPS may also be in charge of metacognition. It's interesting to note that research reveals that metacognition and game-based learning can both influence various brain regions; however, the particular brain regions affected can vary depending on the individual, the activity, and the situation. More specifically, the insula, prefrontal cortex, and anterior cingulate cortex are all active during metacognition. These areas mediate executive functions such as attention, working memory, and decision-making [82–83]. Gamification-based learning, however, has been demonstrated to activate a number of brain regions associated with motivation, reward processing, and attention. The amygdala, prefrontal cortex, and ventral striatum are a few of these [84]. For instance, the ventral striatum is connected to the rewarding part of game-based learning activities, but the prefrontal cortex is involved in planning and decision-making during these activities [80]. However, gamification-based learning and metacognition have complicated and poorly understood impacts on the brain. Along with the possible impacts of various gamification and metacognitive activities on distinct brain regions, individual differences in learning preferences and styles may also be important.

To our knowledge, there isn't any research that specifically examines the function of these components collectively with reference to the neurocognitive link between SPS, meta-cognition, and game-based learning [85]. However, each of these elements has a unique potential influence on how the brain functions. For the employment of game-based learning aids in the classroom, the aforementioned study on the neurocognitive relationship between environmental sensitivity and metacognition may have significant ramifications. The shared neural networks in metacognition and SPS during development may have significant effects on how well children learn [62]. In a similar vein, gamification-based learning can also activate different areas of the brain associated with reward, motivation, and attention that are critical in early-year learning [65].

5.2 Practical implications

Designing successful educational interventions may require further investigation in this field of study. First of all, educators could better accommodate students with high SPS by having a better grasp of the underlying brain networks. For instance, children with high SPS may be more susceptible to environmental distractions such as noise or bright lights, which can affect their learning potential. In order to improve their ability to learn, their learning environment may be changed to remove sensory distractions. Additionally, a deeper comprehension of the brain processes underlying metacognition may help guide instructional strategies for developing metacognitive abilities in young learners [1]. Young learners could benefit from the development of metacognitive abilities by including tasks that encourage reflection and self-awareness, such as journaling or self-evaluation activities. The explicit teaching of thinking regulation and monitoring by educators could also aid in improving the learning efficiency of students [86].

One way that the research on the neurocognitive link between metacognition and environmental sensitivity may be helpful in gamification applications is the creation of mobile games that are better adapted to the demands of learners with high levels of environmental sensitivity [79]. To make mobile games more pleasurable for people with high SPS, mobile game designers may, for instance, provide options that let learners adjust the sensory environment of the game, such as the ability to change the brightness or volume. Designers could also add elements such as opportunities for reflection and feedback on learners' performance that aid in the development of metacognitive abilities [87]. Additionally, mobile game designers might include elements that call for learners to exercise inhibitory control or cognitive flexibility, both of which are frequently impaired in people with high SPS. In the mobile game, for instance, having players pause and deliberate before choosing their course of action might aid in the development of inhibitory control.

Research has shown that the neurological connection between metacognition, contextual sensitivity, and gamification-based learning has important ramifications for the development of gamification applications in child learning [88]. Further research into these relationships may also assist in guiding the creation of mobile games that are better adapted to the demands of learners with lower executive function or cognitive flexibility, as seen in people with high SPS [89]. For example, designers may include elements that make the player pause and consider their choice before selecting it in the mobile game, helping students to build inhibitory control. Additionally, designers could incorporate components that make students switch between tasks using different sensory modalities, which helps with the development of cognitive flexibility.

Gamification and the understanding of the neurocognitive processes that underlie learning and development are both crucial to individualized instruction in special education [90]. Differentiated teaching is a strategy in which teachers adapt their lessons to each student's specific requirements and aptitudes. Teachers can design a learning environment that is interesting, motivating, and matches the individual needs of each student by incorporating gamification into diversified teaching practices. For children who have difficulty processing sensory information, educators can create gamification-based learning programs that provide sensory stimulation in a regulated and adaptable manner. This will enable the student to progressively adjust to the sensory environment. Overall, educators can tailor the learning environment to each student's needs by using techniques that highlight the neurocognitive mechanisms that underlie learning and development. This will eventually lead to improved academic and social results.

Overall, the evidence suggests that technology might be a useful tool for promoting these dimensions in educational environments, while additional study is required to properly understand the relationships between information technologies, metacognition, and SPS. The use of information technologies in areas like personalized learning, teamwork and communication, and data analysis can aid students in growing their capacity for metacognition. Personalized education, for example, can help students better understand their unique learning preferences and change their techniques accordingly, while cooperation and communication can promote metacognitive reflection and problem solving. Students can develop metacognitive self-regulation abilities and a better awareness of their strengths and shortcomings by receiving feedback on their learning progress through data analytics, which helps them. Gamification applications for child learning may become more useful and specialized if knowledge of the neurocognitive mechanisms behind SPS, metacognition, and game-based learning is incorporated [79]. To completely comprehend the connections between these constructs and their consequences for educational interventions, more research is, however, required.

6 DISCUSSION

Finally, it's critical to emphasize how beneficial and productive all digital technologies are for the field of education. The use of these technologies, which include mobile devices [92–93], a range of ICT apps [94–95], and especially games [96], facilitates and improves educational processes, including evaluation, intervention, and learning. In addition, the use of ICTs, theories and models of metacognition, mindfulness, meditation, and the development of emotional intelligence [97–108], speed up and improve even more educational practices and outcomes, particularly for the learning potential of young students.

More precisely, knowing the neurocognitive processes that underlie different elements of learning can help parents and teachers better understand how to create environments that support learning in children. The information regarding the neurocognitive connection between metacognition and environmental sensitivity, as outlined in the present narrative review, could prove valuable in creating gamification-based applications that are tailored to the requirements of learners with varying cognitive profiles, including individuals with hightened levels of environmental sensitivity. Gamification apps should generally be designed with learners' various needs and skill levels in mind, especially those with environmental sensitivity profiles. Educators and parents may help children develop crucial abilities such as motivation and self-regulated learning by using tactics that target these neurocognitive mechanisms. They can also give children an enjoyable and successful learning experience.

On the other hand, information technologies can be used to create learning settings that are more accommodating for children who have SPS. For instance, by allowing students to pick the elements of their learning environment, personalized learning platforms can offer them control over it. Additionally, compared to typical classroom settings, virtual and augmented reality technology can provide students with more immersive and interesting learning opportunities. In conclusion, the employment of information technology in education may have an impact on both metacognition and sensory processing sensitivity by giving students the chance to practice metacognition. There is currently very little research examining the direct impacts of such implementations on a person's potential for metacognition and profile of sensory processing.

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